without active pushing. Using modern analyses of brain imaging in stroke patients, several recent papers have specified which brain structures are involved in verticality perception and lateropulsion. These new findings, mainly obtained with studies of stroke patients, contribute to a better understanding of internal models of verticality with vestibular and somaesthetic graviception synthetised in the postero-lateral thalamus, and predict an improvement of balance by recalibrating verticality representation. Interestingly, this approach brings arguments supporting the relevance of traditional techniques used in clinical practice to attenuate lateropulsion, and points out new tracks for rehabilitation. This argues for a more systematic measurement of verticality perception in stroke patients showing postural disorders.

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Gait stability in paretic patients and its association with tone and strength of the lower limbs

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Keywords: Gait; Stability; Risk of falling; Neurology
Objective.– To explore the gait stability and the association between this parameter and lower limbs disabilities, in neurologically impaired patients.
Patients and methods.– Sixty-one paretic patients following a central nervous system pathology with gait limitations and twenty healthy adults were included. They were asked to walk during 30 seconds wearing an accelerometer set at the lower trunk. The local dynamic stability (LDS), a parameter derived from deterministic chaos theory that may predict fall risk, was calculated [1]. Moreover, the paretic patients underwent a tone and strength examination of the lower extremities.
Results.– Paretic patients walked with a lower frequency (8%, $P < 0.05$) and were more unstable (13%, $P < 0.05$) than the control group. The traumatic brain injured patients showed the highest instability whereas the spinal cord injured patients were the most stable. Significant fair to moderate correlations (r: 0.31–0.43, $P < 0.05$) between the gait data and the tonus were observed. The strength was correlated fairly (r: –0.26, $P < 0.05$), only with the antero-posterior stability index. A higher stability was obtained when the paretic patients had a more normal muscular tone and stronger muscles.
Discussion.– Despite the significant correlation, the force of the association was rather low between the tone/strength and the stability parameters ($r < 0.50$). However, hypertonia and reduced strength were not the only impairments that the patients exhibited and that could influence negatively gait stability. Because it is well known that falls are frequent in these patients, our results can be interpreted as new evidence that LDS is a relevant index for global gait stability and risk of falling. An efficient prevention should be based on early parameters that could warn practitioners of the imminence of future falls before they occur. The use of the accelerometry enables to calculate these parameters and it is an easy method to perform with a minimal constraint to the patient.

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Improving verticality perception reduces lateropulsion after hemisphere stroke

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Introduction.– A biased perception of verticality is linked to lateropulsion after stroke which is a cause of postural disability and as a consequence limits the functional recovery. Does a normalisation of verticality perception based on the crucial role played by gravitational somesthesia in the internal model of verticality [1] can both reduce the lateropulsion and improve the dynamic balance?
Objective.– The aim of the study was to assess the existence of a reduction of lateropulsion after hemisphere stroke using a simple ipsilesional body tilt which is known to increase the weight of the somesthetic graviception (unimpaired in the internal model of verticality; [2]).
Method.– The postural vertical (PV) of 18 hemisphere stroke patients (11 rights/7 lefts; age: 54 ± 13 years; delay: 3 ± 2 months) and 12 controls was measured before and after a 10 minutes lateral body tilt of 30°. The effect of this tilt on lateropulsion and dynamic balance was subsequently investigated in the 12 patients and 12 controls who were able to realise a dynamic balance task in sitting position (rocking platform paradigm). The number of aborted trials and the mean orientation of the plateform were used as measures of lateropulsion.
Results.– In controls, the PV was accurate (0.1 ± 0.7°) but strongly modulated by a body tilt ($P < 0.0001$). In patients, the PV was contralesionally biased (3.6 ± 3.7°). After an ipsilesional tilt, the PV was normalised (0.7 ± 7°; $P < 0.001$) and the lateropulsion reduced (–3.2 ± 2.8° vs –0.1 ± 2.0; $P < 0.001$) resulting in an improvement of dynamic balance with less aborted trials (0.27 ± 0.19 vs 1.56 ± 0.56; $P < 0.02$).
Discussion.– A simple ipsilesional lateral body tilt (10 minutes at 30°) can improve the sense of verticality and the dynamic balance which are ipsilesional biased after stroke. Our hypothesis were based on a theoretical frame recently established [2] and our results encourage the integration of the ipsilesional body tilt in clinical trial of rehabilitation dedicated to verticality and lateropulsion.

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Complex movements induced by multiple vibrations after stroke: The stepping-in-place example

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Keywords: Hemiplegia; Muscle tendon vibration; Proprioception; Gait
Background.– Stroke patients have sensorimotor impairments that interfere in achieving functional tasks such as walking. Tendon vibrations induce an illusion of movement in the direction of stretching of the vibrated muscle and a motor response in the vibrated muscle or its antagonist. It could therefore be possible to induce complex stepping-in-place illusions and movements by applying vibrations appropriately.
Objective.– To determine whether the application of a vibration pattern which produces gait-like sensory activity can induce gait-like movements, among stroke patients, without any voluntary command. Material: Seven stroke patients (walking speed: 0.2 to 0.9 m/s, mean = 0.56 m/s) attended two experimental sessions. Vibrations were applied for one minute by twelve vibrators placed on the flexor and extensor muscles of the lower limbs. The subject was standing using a body weight support system. Vibrations were applied in a gait-like pattern organized in cycles of 1 or 2 seconds. Kinematic data were recorded using a motion capture NDI Certus system. The amplitude

and frequency of movements created at the knees and hips were analyzed in the trials where responses to vibration were the best, as determined by visual analysis of joint movements.
Preliminary results.– Repeated and alternated movements of flexion and extension at the knees and hips were measured in response to the applied vibrations. The period of the cycles of the induced movements was equivalent to that of vibration cycles of 1 and 2 seconds for 81 and 92% respectively of cycles recorded. The amplitude of motion ranged from 0.4 to 7.9° at the knee and from 0.2 to 4.4° in paretic hip.
Discussion.– The application of a complex pattern of vibration can trigger, in hemiparetic subjects, rhythmic movements of small amplitude in the absence of voluntary command. It could provide a means of early rehabilitation training for different populations. These results should be compared with those obtained in healthy subjects.

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Lower limb coordination patterns during gait in hemiparesis – study in a cohort of 41 patients

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Keywords: Hemiparesis; Gait; Inter-segmental coordination; Continuous Relative Phase; Gait velocity; Hyperactivity; Soft tissue retraction; Botulinum toxin
Introduction.– Paresis, muscle overactivity and soft tissue contracture are the three main mechanisms responsible for gait disturbance in hemiparesis. In the rehabilitation management of hemiparetic patients, clinicians may try to determine the responsibility of each mechanism and to quantify the impact of treatment on movement organization and gait efficiency. Inter-segmental coordination analysis, using measurement of the Continuous Relative Phase (CRP) in the sagittal plan, may assist in reaching these objectives [1–3].
Methods.– A cohort of 41 patients with chronic hemiparesis and a group of 20 healthy subjects were analyzed [1–3]. The CRP between lower limb segments was quantified during gait at spontaneous and maximal velocity.
Results and discussion.– The amount of dephasing between lower limb segments, in each phase of the gait cycle, sheds light on the coordination pattern. Relevant parameters of the inter-segmental CRP (ie. RMS, peaks, mean, standard deviation, first derivative) may reveal specific information such as the predominance of neurological or orthopedic factors in the kinematic deficits, the impact of various conditions of gait rehabilitation, or treatment-related benefits. This analysis, complementary to routine clinical examination, may also disclose specific motor deficits in the paretic lower limb, [1–3] and compensatory strategies at work in the non-paretic lower limb [1–3].
Conclusion.– These findings may encourage rehabilitation clinicians to carefully study coordination patterns, which may help optimize treatments to lessen gait impairment in spastic paresis.

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Spatiotemporal gait characteristics of hemiplegic patients

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Keywords: Gait speed; Hemiplegia; Asymmetry; Spatiotemporal parameters
Introduction.– The measurement of spontaneous walking speed is the usual descriptor of the gait performance of the hemiplegic. The maximum walking speed, and the parameters of temporal and spatial symmetry also seems interesting to characterize the gait of the hemiplegic. The objective was to study the spatio-temporal asymmetries of the gait with respect to the lateralization of hemiplegia, and to determine the parameters best correlated with motor impairment and function, at spontaneous and maximum walking speed.
Patients and methods.– Thirty-two stroke hemiplegic subjects (50 $\pm$ 14 years, 53% of left hemiplegia) conducted a standardized assessment of gait with a Locometre, at spontaneous speed (VS) and maximum speed (VM). The motor level assessed by the motor sub-score of the lower limb Fugl-Meyer (FMinf) is 22.3 $\pm$ 7.4 of 34. The functional level assessed with the FIM is 106.8 $\pm$ 15 of 126. An index of temporal asymmetry (or IAT, obtained from time to single-leg support right and left) and spatial asymmetry (or IAS, obtained from the step length left and right) were calculated.
Results.– A high temporal asymmetry is always at the expense of hemiplegic side, while a high spatial asymmetry is divided equally between healthy and injured side. The correlation coefficient is high and significant ($P < 0.001$) between the score FMinf and the IAT at VS and VM (–0.68 for both), the VM (0.66) and the VS (0.65). The correlation coefficient remains significant but with low value between the score FMinf and IAS expressed in absolute value (–0.38 with $P = 0.03$ at VS and –0.46 with $P = 0.008$ at VM). The correlation coefficient is high and significant ($P < 0.01$) between the MIF and the IAS expressed in absolute value at VM (–0.72) and VS (–0.62), the IAT at VM (–0.53) and VS (–0.51), the VM (0.53) and VS (0.49).
Discussion.– The IAT appears to be the most interesting parameter because of its validity and its qualitative aspect. Conducting an assessment at maximum speed seems to improve the validity of gait parameters compared to the spontaneous speed.

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Efficacy of long term physical therapy on walking activity in chronic stroke: Interim analysis

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Keywords: Stroke; Hemiplegia; Physical therapy; Gait; Walking activity
Objectives.– The aim of this multi-center, randomized controlled study is to assess the efficacy of continuing physical therapy twice a week during 8 weeks at the chronic phase of post-stroke hemiplegia (six months to two years post-stroke) as compare to an 8 weeks break of the physical therapy.
Methods.– multicenter (CHU de Saint-Étienne, Angers, Nancy, Bordeaux), randomized, parallel, single-blind study. Included patients were first ever stroke at a chronic stage (6 months to 2 years), living at home and able to walk with or without assistive technologies. The therapeutic group followed an 8 weeks program of gait-oriented physical therapy, whereas the control group stopped the physical therapy during 8 weeks. The main outcome measure was the walking activity as assessed during 3 days (excluding the days with physical therapy) by a magnetometer-based step counter. These measures were performed before and after the therapeutic program.